MacroNode I/O™
User Manual

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Preface

About this manual

This manual is designed to serve as a guideline for the installation, setup, operation and basic maintenance of the MacroNode device. The information contained within this manual, including product specifications, is subject to change without notice. Please observe all safety precautions and use appropriate procedures when handling the MacroNode product and its related software.

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General Information

The MacroNode I/O™ product line provides high density, compact and economical I/O solutions for Ethernet Networks. The MacroNode supports up to 4 expansion slots of I/O which can be ordered with any arrangement of digital, analog or combination cards. Both Modbus/TCP and Ethernet/IP networks are supported. Additional data monitoring is available through a standard web browser and the TOOLweb™ tool side Interface (XML over HTTP). The MacroNode package provides DIN rail mounting and easy access to I/O through standard 37-pin D-Sub connectors.

1.1 Conventions used in this User Manual

	Warning	**The WARNING sign denotes a hazard to personnel. It calls attention to a procedure, practice, condition, or the like, which, if not correctly performed or adhered to, could result in injury to personnel.**
	Caution	**The CAUTION sign higlights information that is important to the safe operation of the MacroNode, or to the integrity of your files. .**
	Note	The NOTE sign denotes important information. It calls attention to a procedure, practice, condition, or the like, which is essential to highlight.

On screen buttons or menu items appear in bold and italics.
Example: Click ***OK*** to save the settings.

Keyboard keys appear in brackets.
Example: [ENTER] and [CTRL]

Pages with additional information about a specific topic are cross-referenced within the text.
Example: (See page xxx)

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2 Installation and Setup

This section describes the MacroNode hardware setup as well as the interface with the Ethernet network. I/O connection examples are given in section 2.4.

2.1 Shipping Box Contents

- MacroNode Product
- Power mating connector

2.2 Hardware Description

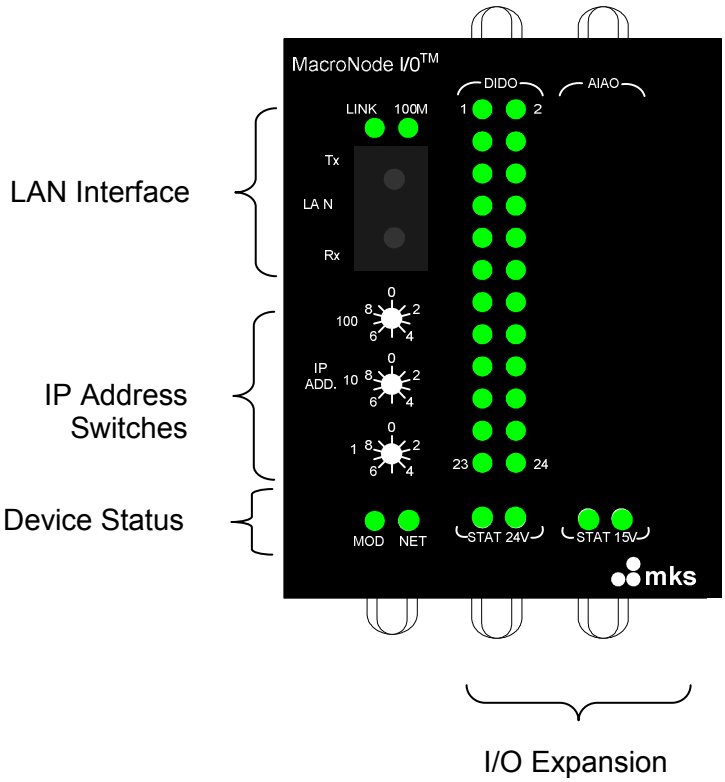

Figure 1 MacroNode Front Panel

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2.3 Installation

The MacroNode mounts on a standard 35mm DIN rail system. Make sure there is sufficient side clearance for ventilation, to maintain an ambient operating temperature of 0°C to 50°C.

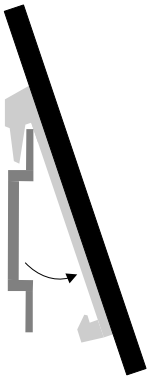


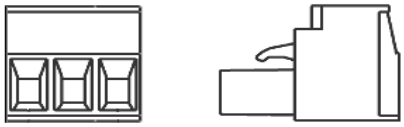
Figure 2 MacroNode DIN Rail Mounting

2.4 Power and I/O Wiring

The MacroNode requires three connections – one to the Ethernet network, one for device power, and one for I/O signals. Ethernet and I/O cables are available from a variety of industrial sources.

2.4.1 Power Supply Wiring

Connect an external 18-30 VDC power supply to the 3-terminal power connector. The connector should be wired according to the labeling on the case.



Pin	Signal
1	18-30 VDC
2	Chassis GND
3	GND

Figure 3 Power Terminal Block

The manufacturer and ordering part number for the power terminal block connector is described in the following table.

Table 1 Terminal Block Ordering Information

Description	MFG	Part Number
3-pin Terminal Block	Weidmuller	1625620000

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2.4.2 I/O Mating Connector Information

The following tables supply reference part numbers for mating I/O connectors. Table 2 describes a connector that uses terminal blocks and therefore appropriate for development. Table 3 contains part numbers that are suitable for production purposes with solder cup connections. Table 2 also contains the part number for a D-SUB hood that conforms to the 0.65 inch (1.65 cm) maximum height requirement.

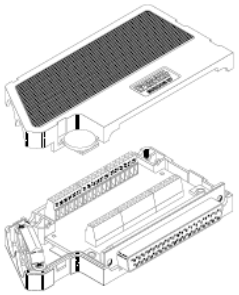

Table 2 Development Mating I/O Connector

Description	MFG	Part Number
37-pin D-SUB with Shell (Terminal Block)	Phoenix	2300986

Table 3 Production Mating I/O Connector and Hood

Description	MFG	Part Number
37-pin D-Sub Receptacle (solder cup)	Mouser	523-L77-DC37S
37-pin D-Sub Metal Hood	Mouser	523-17E-1727-2

Caution **In order to guarantee proper operation and to prevent damage to the product insure that the chassis ground is properly attached for the application.**

Warning **Follow all applicable electrical codes when mounting and wiring any electrical device.**

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2.4.3 Analog Expansion I/O Wiring

The MacroNode analog expansion board has two 37-pin D-Sub connectors used to access the I/O points. Each I/O card type has unique pin assignments; the assignments for the analog card are shown in the following figures.

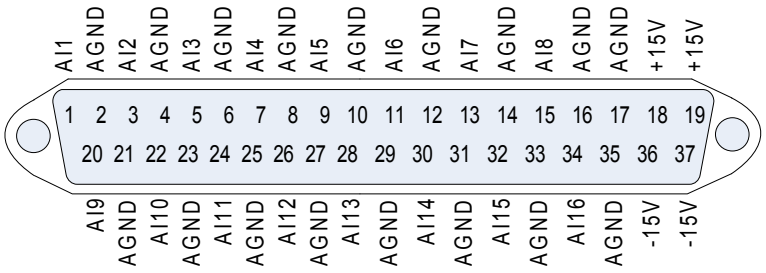

Figure 4a Analog Inputs – Single-ended Mode

Top Side Connector

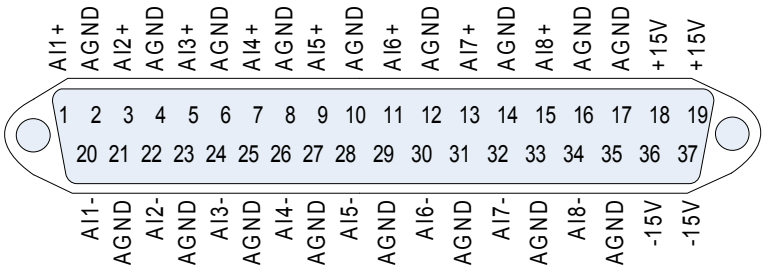

Figure 4b Analog Inputs – Differential Mode

Top Side Connector

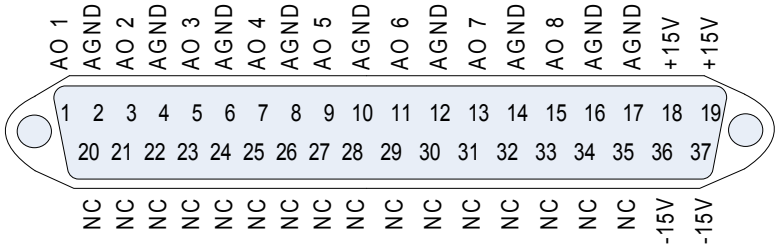

Figure 5 Analog Outputs

Bottom Side Connector

Note

All Analog power comes from an internal power converter. External pins for +/- 15 volts should be used as reference only. Supplies have limited power and should not be used to drive external loads.

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2.4.4 Digital Expansion I/O Wiring

The MacroNode digital expansion board has two 37-pin D-Sub connectors used to access the I/O points. The +24V power must be supplied by an external source via these connectors. Each I/O card type has unique pin assignments; the assignments for the digital card are shown in the following figures. All “24 GND” labels are one net; they are not separate ground points.

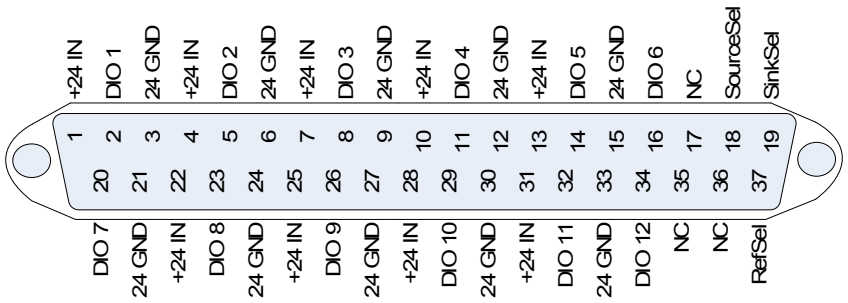

Figure 6 Digital Top Side Connector

Table 4 Source/Sink Select for Digital Top Connector

Sink/Source Select	
Sinking Input/Sourcing Output	**Short Pin 18 to 37**
Sourcing Input/Sinking Output	**Short Pin 19 to 37**

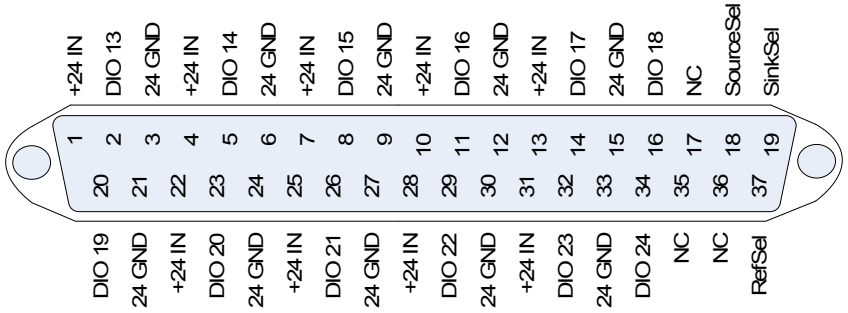

Figure 7 Digital Bottom Side Connector

Table 5 Source/Sink Select for Digital Bottom Connector

Sink/Source Select	
Sinking Input/Sourcing Output	**Short Pin 18 to 37**
Sourcing Input/Sinking Output	**Short Pin 19 to 37**

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2.4.5 Combo I/O Wiring

The Combo I/O Expansion Card has two 37-pin D-Sub connectors used to access the I/O points. The +24V power must be supplied by an external source via these connectors. The ±15V power is supplied by an internal converter. The pin assignments are shown in the following tables. All “24 GND” labels are one net; they are not separate ground points.

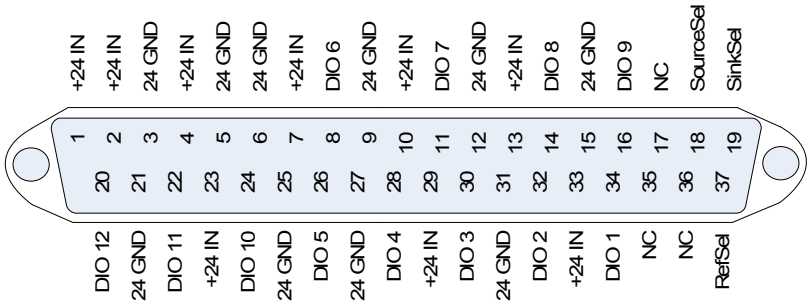

Figure 8 Combo Top Side Connector

Table 6 Digital Source/Sink Select for Combo Top Connector

Sink/Source Select	
Sinking Input/Sourcing Output	**Short Pin 18 to 37**
Sourcing Input/Sinking Output	**Short Pin 19 to 37**

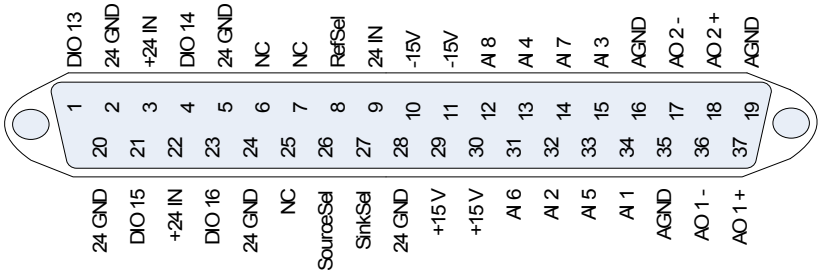

Figure 9 Combo – Diffrential Mode - Bottom Side Connector

Card Type	Number of Inputs	Type
Analog Expansion Card	16/8	Single-ended/differential See Figures 4a and 4b in section 2.4.3 for wiring information.
Combo Expansion Card	4	Differential only Single ended inputs must be connected in pairs to create differential inputs. Particular pairs must be used (input 1-5, 2-6, 3-7, 4-8). Single-ended mode input is not supported on combo card.

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Table 7 Digital Source/Sink Select for Combo Bottom Connector

Sink/Source Select	
Sinking Input/Sourcing Output	**Short Pin 18 to 37**
Sourcing Input/Sinking Output	**Short Pin 19 to 37**

Note

All Analog power comes from an internal power converter. External pins for +/- 15 volts should be used as reference only. Supplies have limited power and should not be used to drive external loads

2.5 Digital Input Interface Example

Digital I/O can be configured as either sinking or sourcing. Each input circuit includes an indicator LED in series with the detection opto-coupler. The opto-coupler provides isolation between the input and the processing circuitry. The inputs require 1.5 mA in order to turn on.

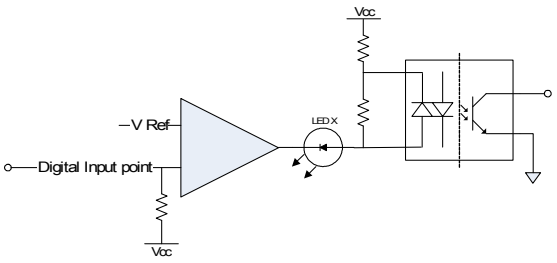

Figure 10 Sourcing Input

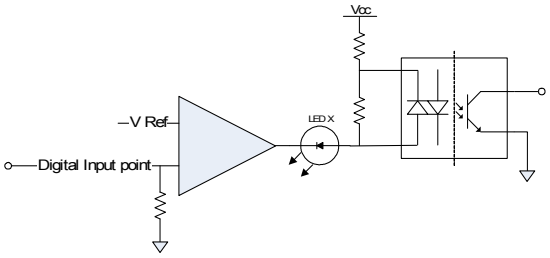

Figure 11 Sinking Input

Below is an example of how to use the digital input interface for both the sinking and sourcing hardware configurations. The digital I/O circuitry is powered from an external +24-volt power source via the I/O connector.

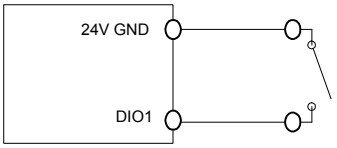

Figure 12 Sourcing Input

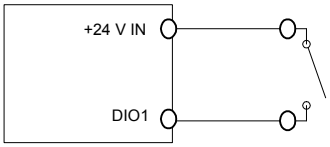

Figure 13 Sinking Input

2.6 Digital Output Interface Example

The individual outputs will support up to a 200 mA load per channel. Each output is thermally protected against short-circuiting (500 mA typically) and includes under voltage protection. The output Fault State is accessible through software. External Schottky diodes are provided for output transient protection and each I/O point is protected with a self-resetting poly fuse rated for 500 mA.

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Outputs default to the OFF condition during power up and processor reset conditions. The figure below shows the output circuitry.

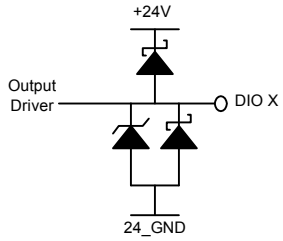

Figure 14 Digital Output

Below is an example of how to interface with the digital outputs for both the sinking and sourcing hardware configurations. The digital I/O circuitry is again powered from an external +24-volt power source via the I/O connector.

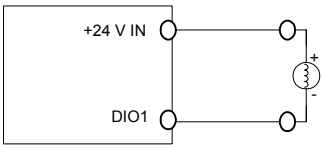

Figure 15 Sinking Output

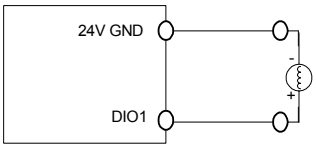

Figure 16 Sourcing Output

2.7 Analog Inputs

The analog inputs are coupled directly to the processor. The processor is limited to 14-bits analog to digital conversion. MacroNode SW allows analog conversion up to 16 bits, single-ended or differential for easy implementation and compatibility. Resolution data is left-shifted if resolution is set at 16-bits. The analog voltage span is fixed at –10V to +10V. See Section 3 for configuration.

All analog circuitry is powered from an internal ±15 Vdc power source. The +15 V and -15 V power is protected with a self-resetting poly fuse rated at 100 mA.

Table 8 Analog Voltage 2's Complement Conversion Table for 12-bits A/D

Conversion Table	
+10 V	0x07FF
5 mV	0x0001
0 V	0x0000
-5 mV	0xFFFF
-10 V	0xF800

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Table 9 Analog Voltage 2's Complement Conversion Table for 14-bits A/D

Conversion Table	
+10 V	0x1FFF
5 V	0x0FFF
0.0012 V	0x0001
0 V	0x0000
-0.0012 V	0xFFFF
-5 V	0x2FFF
-10 V	0x2000

Table 10 Analog Voltage Straight Binary Conversion Table for 14-bits A/D

Conversion Table	
+10 V	0xFFFF
1 V	0x8CCB
0.001 V	0x8003
0 V	0x7FFF
-0.001 V	0x7FFC
-1 V	0x0CCC
-10 V	0x0000

Table 11 Number and Type of AI

Card Type	Number of Inputs	Type
Analog Expansion Card	16/8	Single-ended/differential See Figures 4a and 4b in section 2.4.3 for wiring information.
Combo Expansion Card	4	Differential only Single ended inputs must be connected in pairs to create differential inputs. Particular pairs must be used (input 1-5, 2-6, 3-7, 4-8). Single-ended mode input is not supported on combo card.

2.7.1 Configuring Analog Inputs

Analog inputs can be configured as single-ended, differential mode, up to 16-bit resolution, straight binary or 2's complement format. These are configured through the Webpage interface. To configure these, unit has to be reset and the unit Webpage is refreshed within 30 second after the unit boots.

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2.8 Analog Outputs

The analog outputs are implemented using 12 bit D/A's with a –10V to +10V output range. MacroNode allows configuration up to 16-bits for compatibility. Data is left-shifted is resolution is set higher than the HW resolution at 12-bit DAC. Analog outputs can also be configured as 2's complement or straight binary. The output drivers are capable of driving 2 KΩ (5 mA) output loads. Analog outputs default to 0 volt during power up and processor reset conditions.

Table 12 Analog Voltage 2's complement Conversion Table

Conversion Table	
+10 V	0x07FF
5 mV	0x0001
0 V	0x0000
-5 mV	0xFFFF
-10 V	0xF800

Table 13 Number and Type AO

Card Type	Number of Outputs	Type
Analog Expansion Card	8	Single-ended outputs See Figure 5 in section 2.4.3 for wiring information.
Combo Expansion Card	2	Differential outputs See Figure 9 in section 2.4.5 for wiring information.

2.9 Diagnostic Serial Port

The MacroNode has an RS-232 serial diagnostics interface available. The serial port will also provide access to a proprietary command-line interface, with specific commands to display advanced or detailed status information, and control of configuration parameters including those available via the Web interface, and others that are intended for advanced or factory use, that are not normally exposed via the Web interface.

The command-line interface supports the "**help**" command, which displays a brief synopsis of all other supported commands, which should be self-explanatory to anyone sufficiently familiar with the controller theory of operation, and the technologies involved (see section 3.2 for how to connect the unit using serial COM port).

The diagnostics serial port is also used to display all legally required Copyright messages, current version information and hardware configuration information during the unit's power-up sequence.

Table 14 Diagnostic Serial Port Connector Pin-Out (DB-9 Female Connector)

Pin	RS232 Function
2	TXD
3	RXD
5	SGND

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2.10 Ethernet Connector

The 100/10 BaseT Ethernet Port uses a standard shielded RJ45 connector or Fiber Optic Channels. Indicators for the Ethernet Port are located on the front panel.

2.11 Status LED's

The MacroNode has one LED that indicates the unit status and an additional LED that indicates the network status. The function of these LED's meets the requirements for each network protocol. The following tables describe meaning of the various LED state for each protocol.

Table 10 Modbus/TCP Status LEDs

LED Color	Status LED	Network LED
Off	No power	No Power
Solid Red	Not Supported	No Network Response (Disconnected)
Solid Amber	Booting	Network Initializing, configuring DHCP
Alternating Red-Green	Watchdog failure, outputs off	Network Configuration Error
Alternating Red-Amber	I/O failure	Null network, IP address configuration Error
Alternating Green-Amber	Not Supported	Not Supported
Blinking Amber	Unit Okay, Diagnostic Mode, Watchdog Inactive	Standing by for Modbus master to connect
Blinking Green	Unit Okay, Production Mode, Watchdog Active	Modbus master present and active

Table 11 Ethernet/IP Status LEDs

LED Color	Status LED	Network LED
OFF	No Power	No Power
Solid Green	Device Operational	Connected
Blinking Green	Not Supported	No Connections
Blinking Red	Minor Fault-recoverable	Connection Timeout

2.12 Rotary Switches

The Ethernet MacroNode has three rotary switches on the front panel, each switch representing a decimal digit 0 through 9. These three switches serve two purposes:

1. Determines the least significant section of the IP address
2. Determines the operating mode

Table 12 Switch Conditions

Mode	Switch Settings	Watchdog	IP address
Production	000	Enabled	DHCP
Production	001-254	Enabled	192.168.0. (Switch Settings)
Diagnostic	300	Disabled	DHCP
Diagnostic	301-554	Disabled	192.168.0. (Switch Settings – 300)

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When the unit is in **normal (production)** mode, the combinations of the rotary switches represent a decimal number between 000 and 254. When the number is between 001 and 254, this number is used to configure the last network segment of the **static** IP address, with a factory set prefix 192.168.0.xxx, or any other prefix that may be configured through the diagnostic serial port. If the rotary switch combination is set to 000, the unit will obtain an IP address automatically using DHCP protocol.

To set the operating mode to **diagnostics mode** set the rotary switches to 300 or above. In Diagnostic mode the watchdog is disabled, and the user is allowed to change the value of the outputs via the Web-based diagnostic pages. Setting the switches to a value of 300 configures the IP address using DHCP, and setting the switches above 300 configures the unit to a static IP address.

For example: A switch setting of 330 means that the diagnostic mode is set, and the IP address is statically configured to 192.168.0.30.

Note	Rotary switches decimal representation above 554 are reserved and should not be used.

2.13 I/O Monitoring

There are multiple control and data monitoring interfaces for the unit:

- Modbus/TCP or Ethernet/IP control
- Web browser, manual control
- Web browser, configuration and graphical data monitoring
- XML streaming data acquisition, using TOOLweb™ protocol

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3 Quick-Start

- Set the IP address switches on the front of the unit to **3 1 0**. The unit is now in Diagnostic mode with a static IP address. The units IP address will be 192.168.0.10. Power the MacroNode by supplying +24 volts to the 3-position terminal block power connector.

- Power the I/O modules by supplying +24V for **Digital modules** via the I/O connector. Note Analog +/-15 volts for **Analog modules** is supplied internally.

- Attach a network cross-over cable between the unit and your PC or use a HUB to build a small network.

- Modify your PC network TCP/IP settings using the computer's *Connection Properties* menu to match the following:

  PC IP Address: 192.168.0.1
  PC Netmask: 255.255.255.0

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- Open a web browser window and enter **http://192.168.0.10** in the address line. There is a slight delay as the unit transfers content to your local browser. The main Device page is displayed. If you are unable to load the page, check the units switch settings and ensure the IP address of the PC is 192.168.0.1. Also check the Ethernet cable connections to your PC and to the MacroNode.

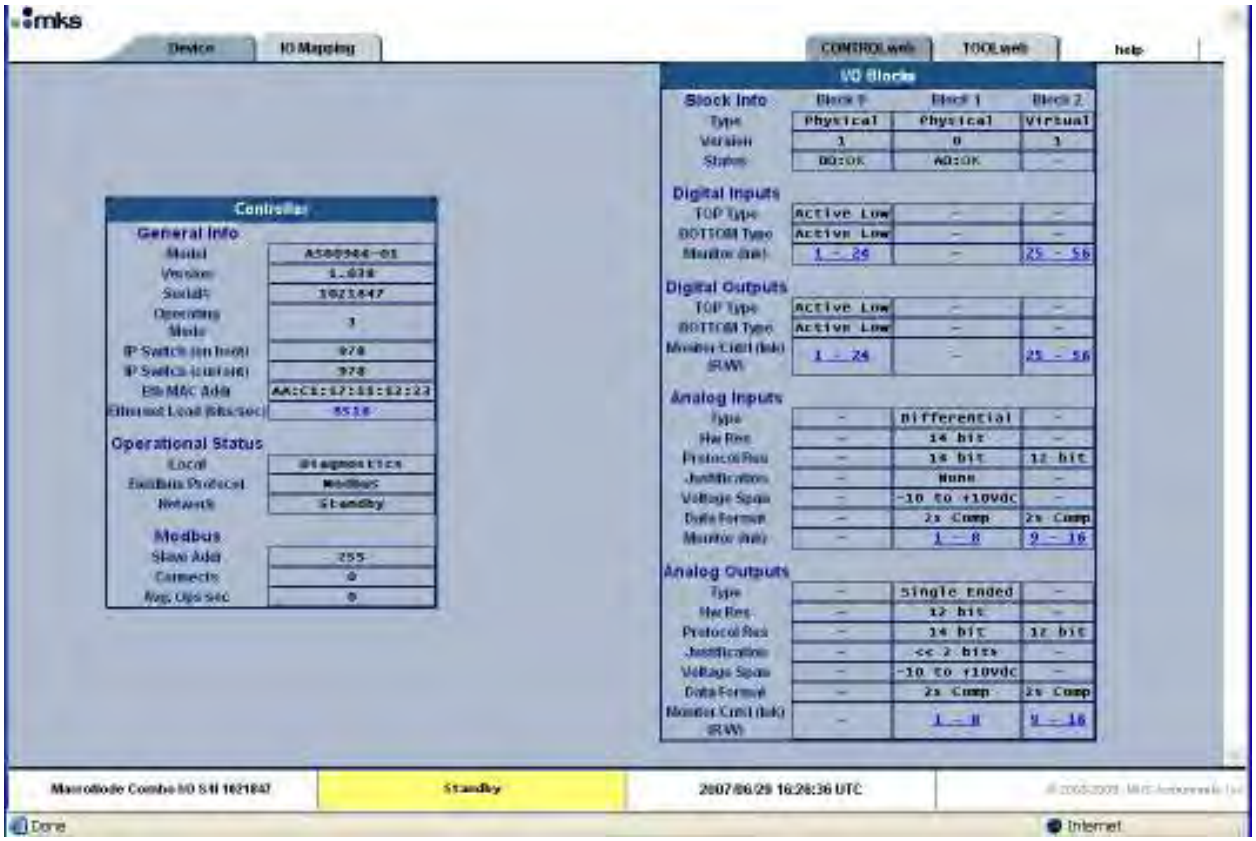

Figure 17 Device ControlWeb page

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- To access configuration mode, reset the unit and refresh the above page within 30 seconds after the unit boots.

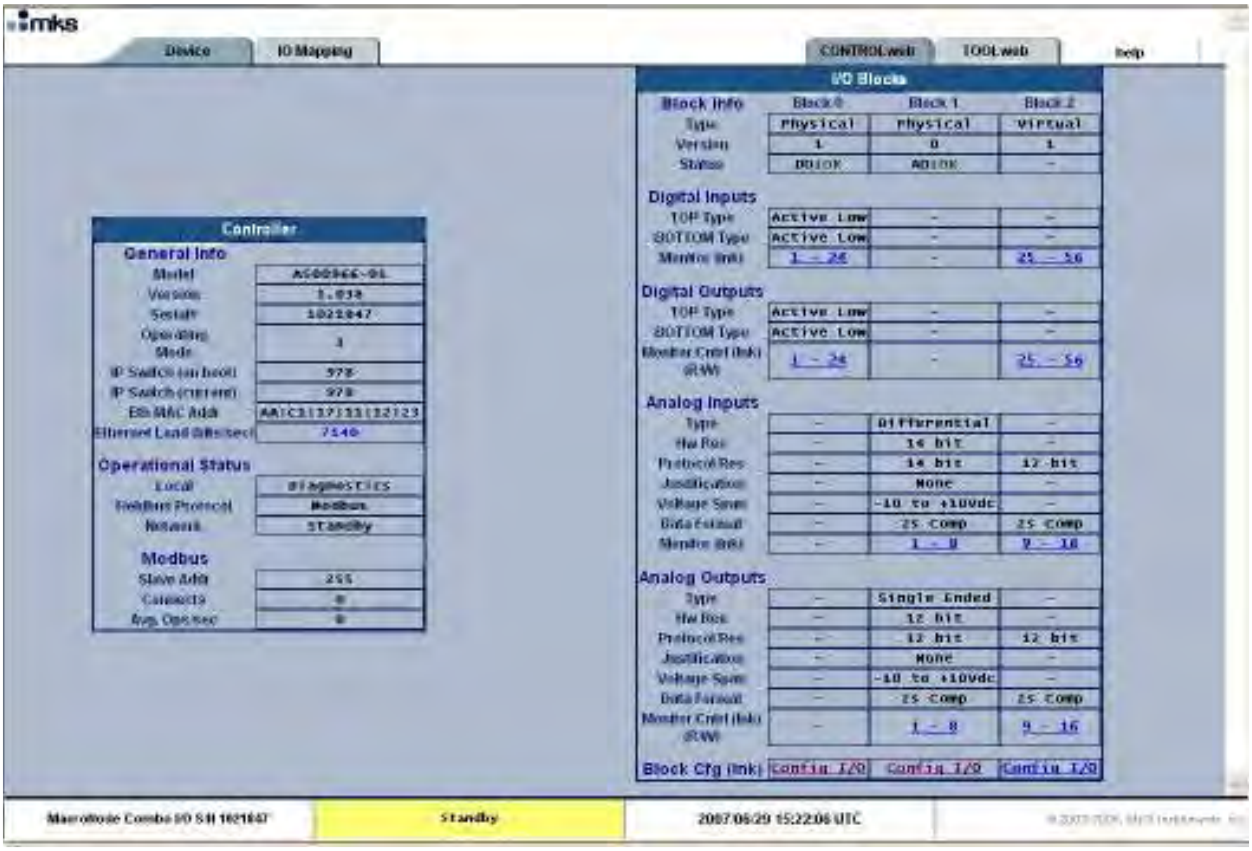

Figure 18 Device Configuration Webpage

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- Click on the Config I/O for the block to open the configuration page for the card. The digital IO card debounce setting for all the digital IO point for the card is currently not implemented. Please refer to cLogic documentation for software work-around.

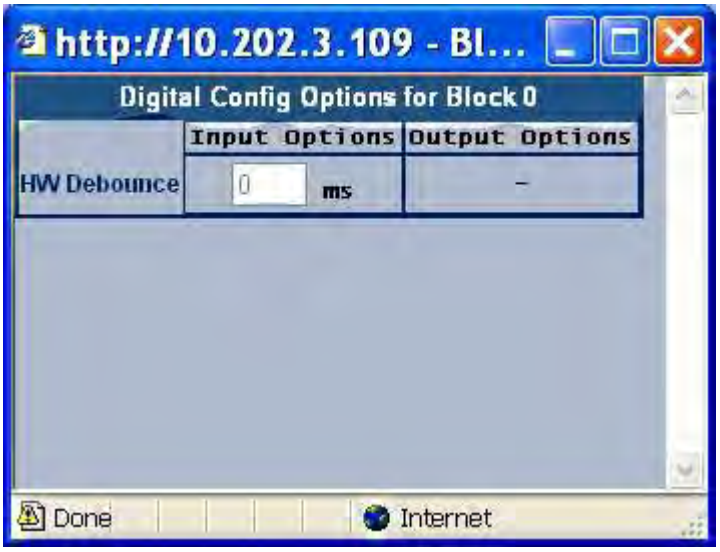

Figure 19 Device Digital Card Configuration Webpage

- The analog configuration is fixed for Ethernet/IP protocol except for analog input for single-ended or differential. Modbus/TCP protocol allows protocol resolution, data representation and type configuration as shown below:

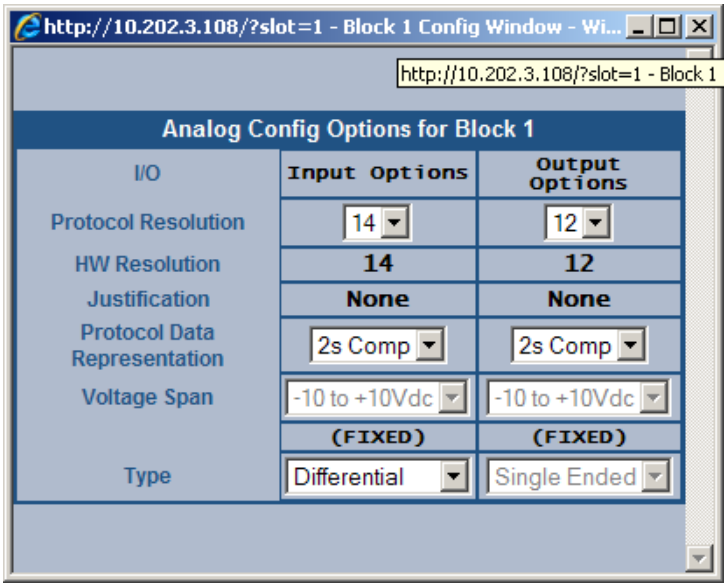

Figure 20 Configurable analog parameters for Modbus/TCP protocol

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- The Device page provides current status on the unit and provides basic I/O control and monitoring when the device is in diagnostic mode. Once in production mode, the outputs can no longer be controlled via the webpage.

- Selecting the underlined items in the I/O blocks chart will launch secondary I/O pages. The following figures show the digital and analog input statuses that are displayed after an underlined link is selected.

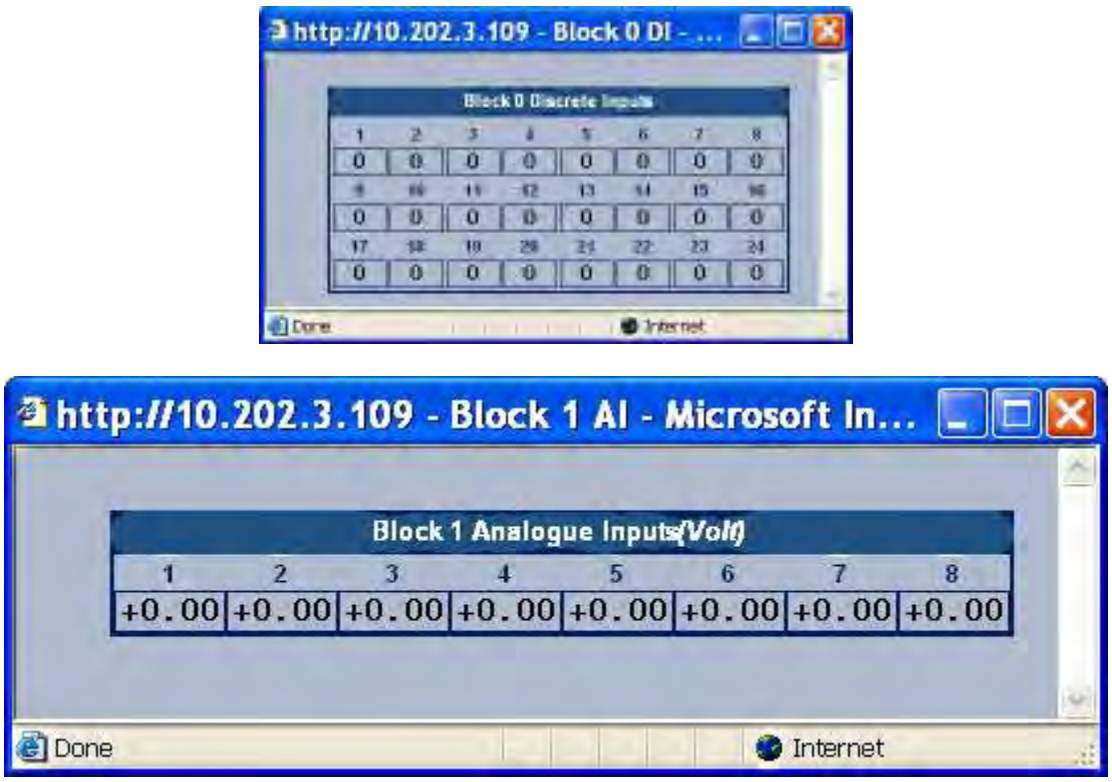

Figure 21 Digital and Analog Input WebPages

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- The digital and analog output WebPages provide basic control of the output points if the unit is in **diagnostics mode**. The pull down menu allows the user to select the digital output state or to enter in a value for an analog output. There is also a Blinking Output pull down menu that allows the user to put an output into a blinking or oscillating state.

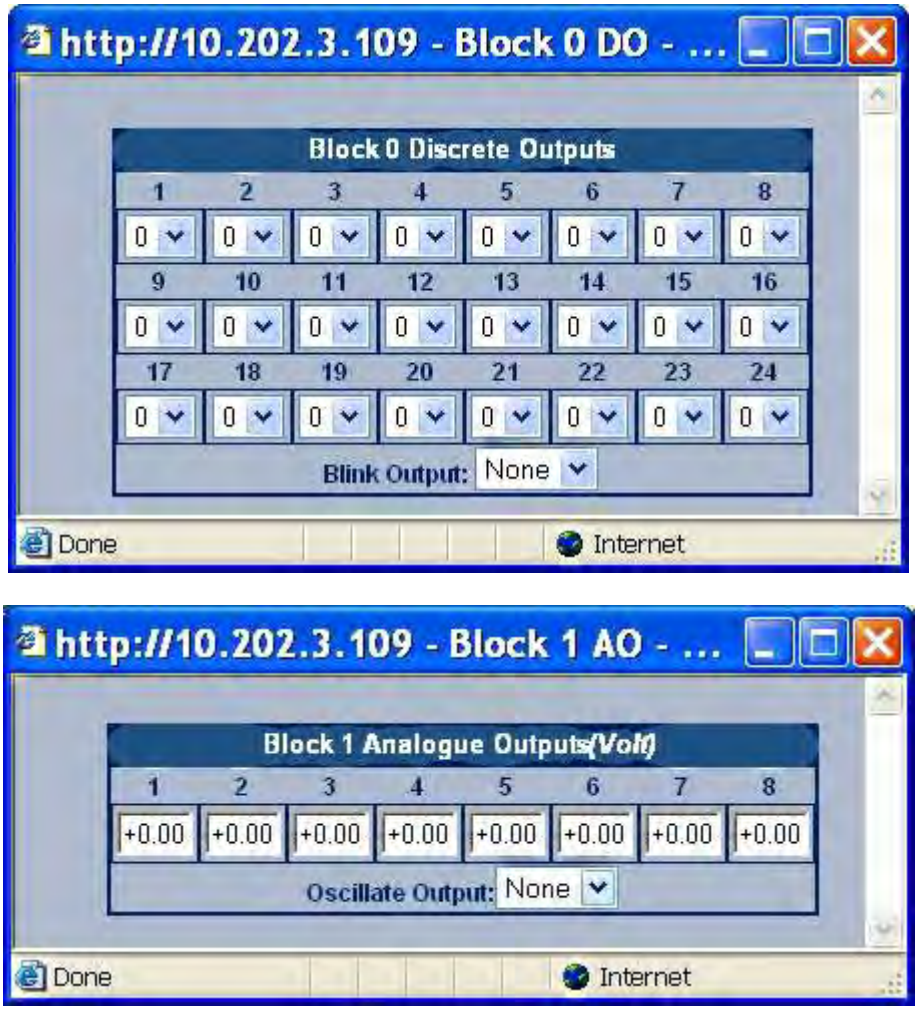

Figure 22 Digital and Analog Output WebPages

- Click on the link for the analog or digital output page. Change the state of one of the outputs by selecting an option from the pull down menu and for the case of analog enter a number within the range of –10V to +10V.

If the output does not come on, check the status and network LEDs on the front of the unit. The module LED should be blinking amber and the network LED should be blinking green. If the states are different, reference the LED status table in section 2.10. Also, check all power connections.

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Network Configuration

The MacroNode network settings configure the 10/100 BaseT Ethernet port. The following are factory-default Ethernet settings.

Parameter	Setting
IP-Address	192.168.0.X
Subnet mask	255.255.255.0
Default Gateway	None

Note Reading or changing the network settings of an unknown unit is achieved by connecting via a serial terminal session.

3.1 Connecting to a computer via TCP/IP

The Ethernet MacroNode is configured and controlled via its Ethernet port. The following steps show how to configure a Windows PC for first-time communication with a unit.

1) Connect the unit to your PC by using an Ethernet crossover cable for direct point-to-point connection, or connect through an Ethernet switch or hub.

Note Some 10/100MB Ethernet interfaces may not detect the MacroNode™ when using an Ethernet crossover cable. If you experience problems, connect through an Ethernet switch or hub.

2) Change IP switches on the MacroNode to 3 1 0.

3) Change your PC network TCP/IP settings so that PC resides on same sub network as the MacroNode I/O™.

   Use the following TCP/IP settings:

   IP Address: 192.168.0.1
   Subnet Mask: 255.255.255.0
   Default Gateway: none

4) Open your PC web browser (Netscape, Internet Explorer, or equivalent). Enter the IP address in the web browser's address line.

   http://192.168.0.10

   The main page for the MacroNode will open.

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3.2 Connecting via a Serial Terminal Session

Connect your computer to the diagnostics port (DB9) using a standard straight thru cable.

Using a terminal program such as Microsoft® HyperTerminal or Tera Term Pro you can now communicate via the diagnostics port of the unit. The serial connection parameters are listed in the following table.

Table 13 Serial Connection Parameters

Parameter	Value
Baudrate	38400
Data bits	8
Parity	None
Stop bits	1
Flow Control	None

Once connected the IP-Address can be changed by typing the **menu** command and pressing **m** within 3 seconds: The current the IP address of the unit can be view by just typing **menu**.

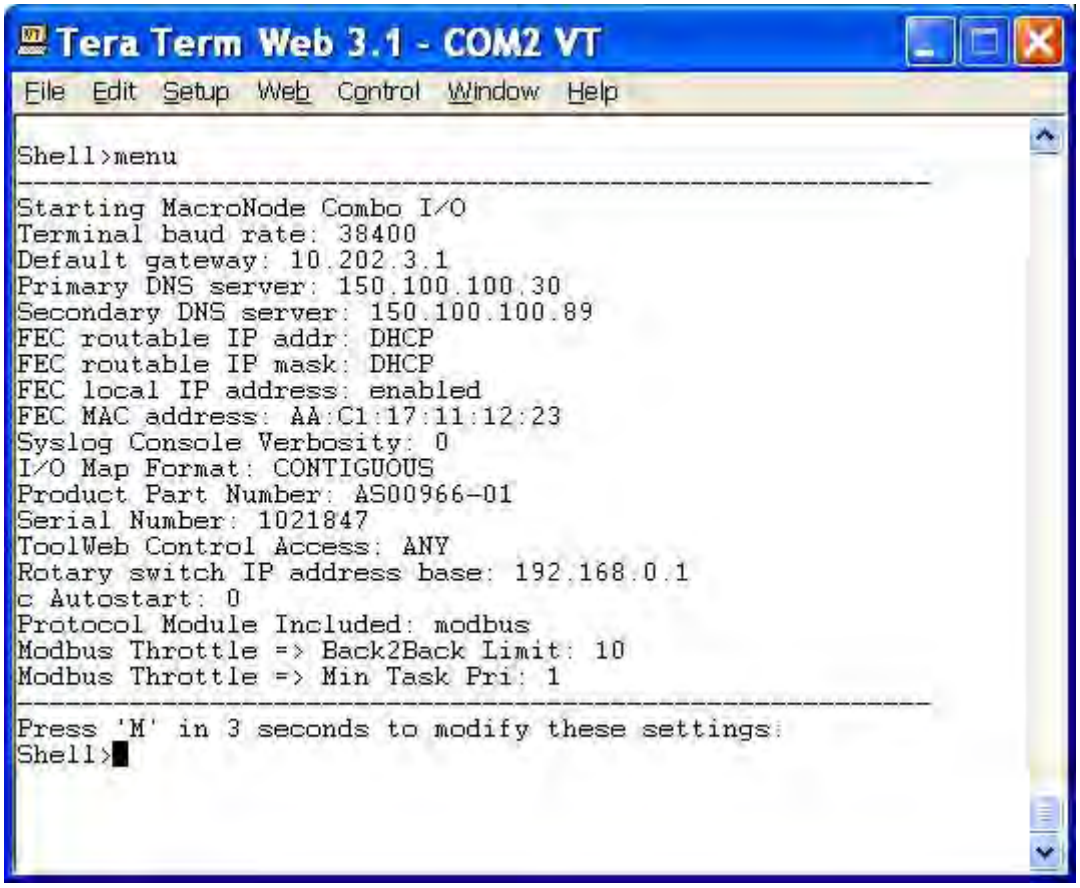

Figure 23 Serial Diagnostics Menu Command

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The modbus Throttle => Back2Back Limit is the number of back-to-back modbus commands threshold before modbus request is changed to lower priority to allow other processes time to run.

Modbus Throttle => Min Task Pri: should be set at 11.

The serial interface provides diagnostics for the device. The **help** command can be used to display all commands available through the serial interface.

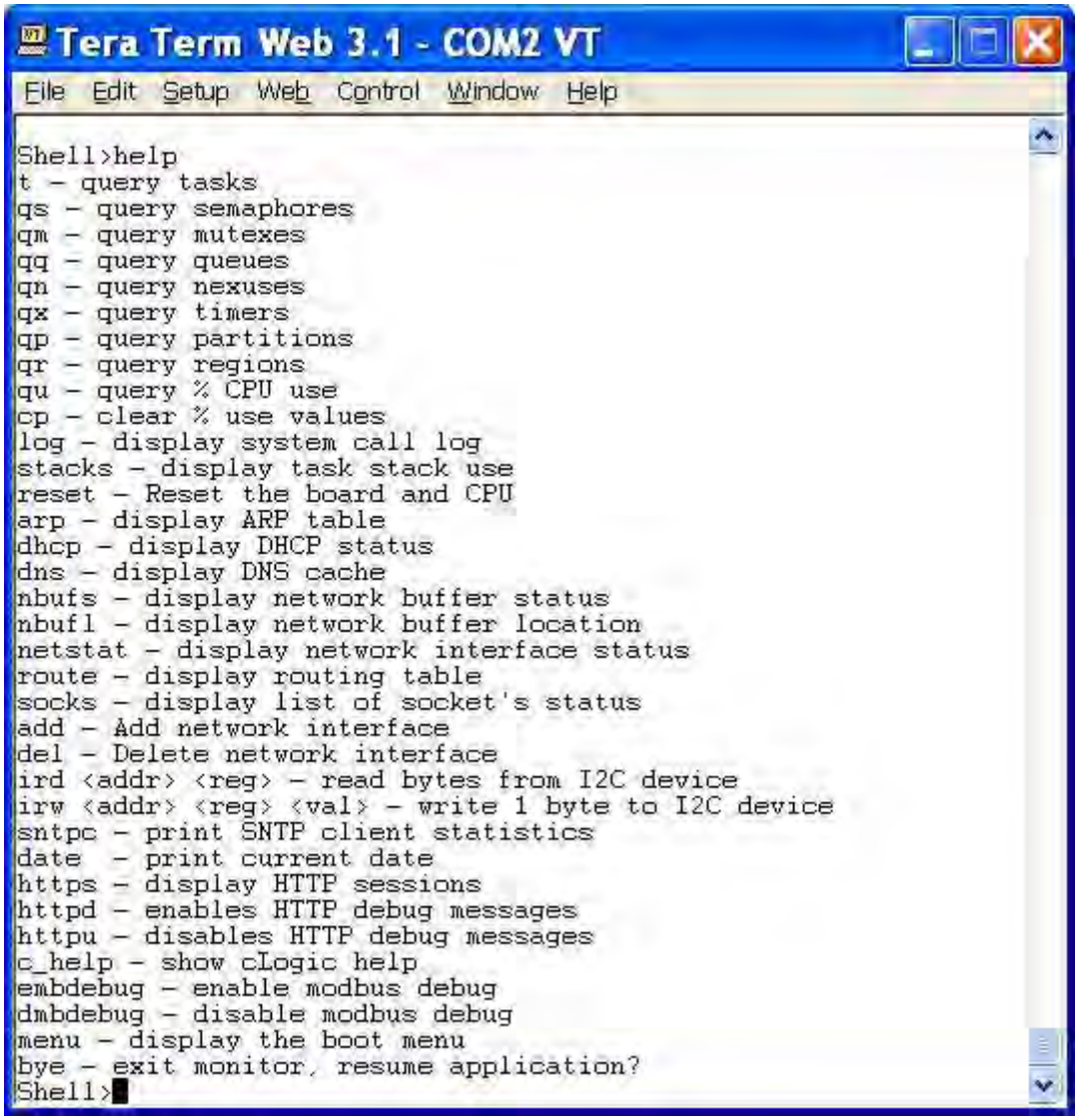

Figure 24 Serial Diagnostics Help Command

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CONTROLweb™ User Interface

The user interface is web based. You can access it by simply browsing to the IP-address of the CONTROLweb™ node.

Note Microsoft Internet Explorer versions older than 5.5 may not function as expected due to limitations of the browser.

The main page of the CONTROLweb™ unit shows a top view of the module. This is referenced as the ***Device*** tab near the top of the page.

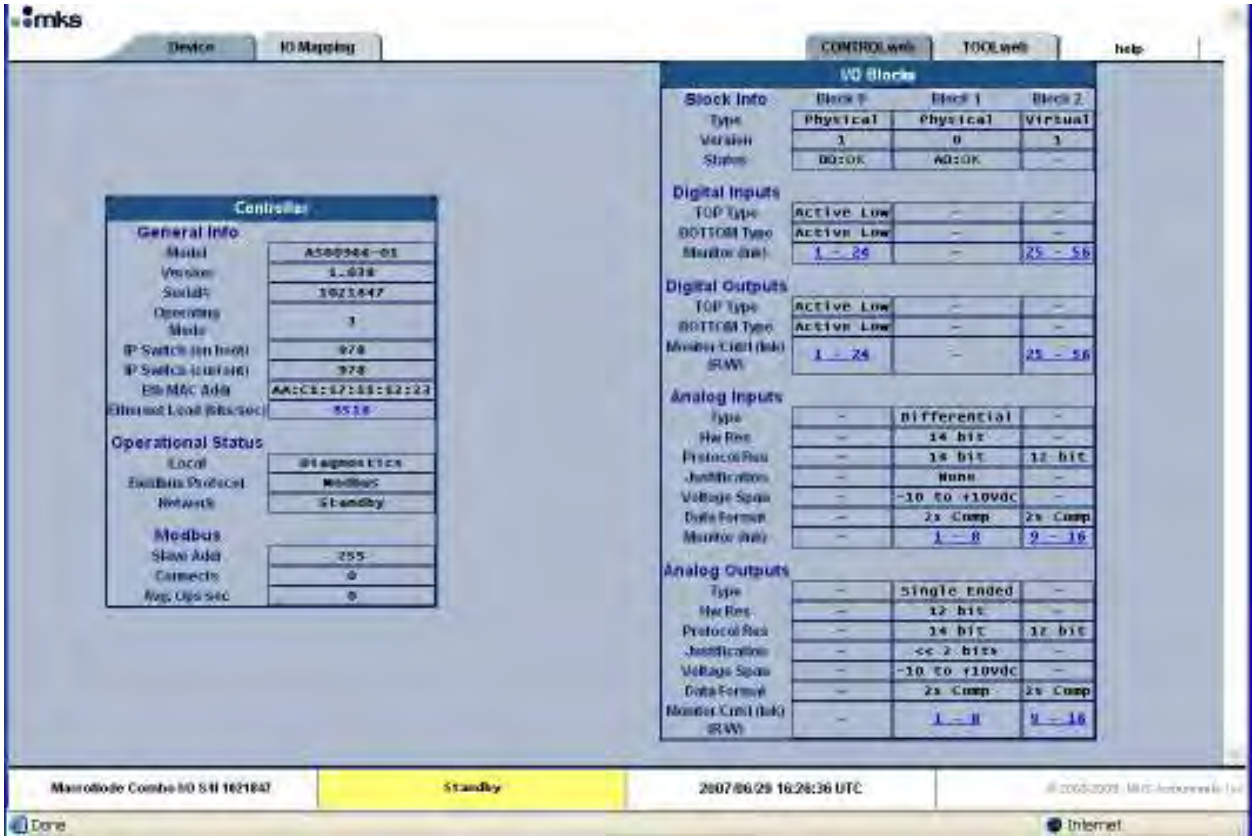

Figure 25 Device Homepage

Dynamic diagnostic details available from this page are:

- Unit data- model number, serial number, and software version
- Operational Mode
- Operation statistics
- Ethernet load
- Fieldbus Protocol
- Unit MAC address

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By selecting an I/O of interest from the main page, a pop-up will appear for each section of I/O.

- Inputs can be read. (dynamic)
- Outputs can be set manually if the unit is in diagnostics mode

Note The I/O is arranged in blocks, which represent expansion modules. The last block is always a virtual I/O block which can be used in conjunction with the cLogic feature. Please contact MKS for the cLogic API document for more information on implementing the virtual I/O.

I/O Mapping-Modbus/TCP

The unit Modbus Slave ID is fixed at 255.

The Modbus mapping details can be viewed through the web browser interface by clicking on the ***I/O Mapping Tab*** from the main page. The figure below is one example of what will appear on the screen. The mapping will change depending on which I/O expansion modules are installed and whether IO mapping is in block or contguous. The last block is not a physical expansion module; it consists of virtual I/O only.

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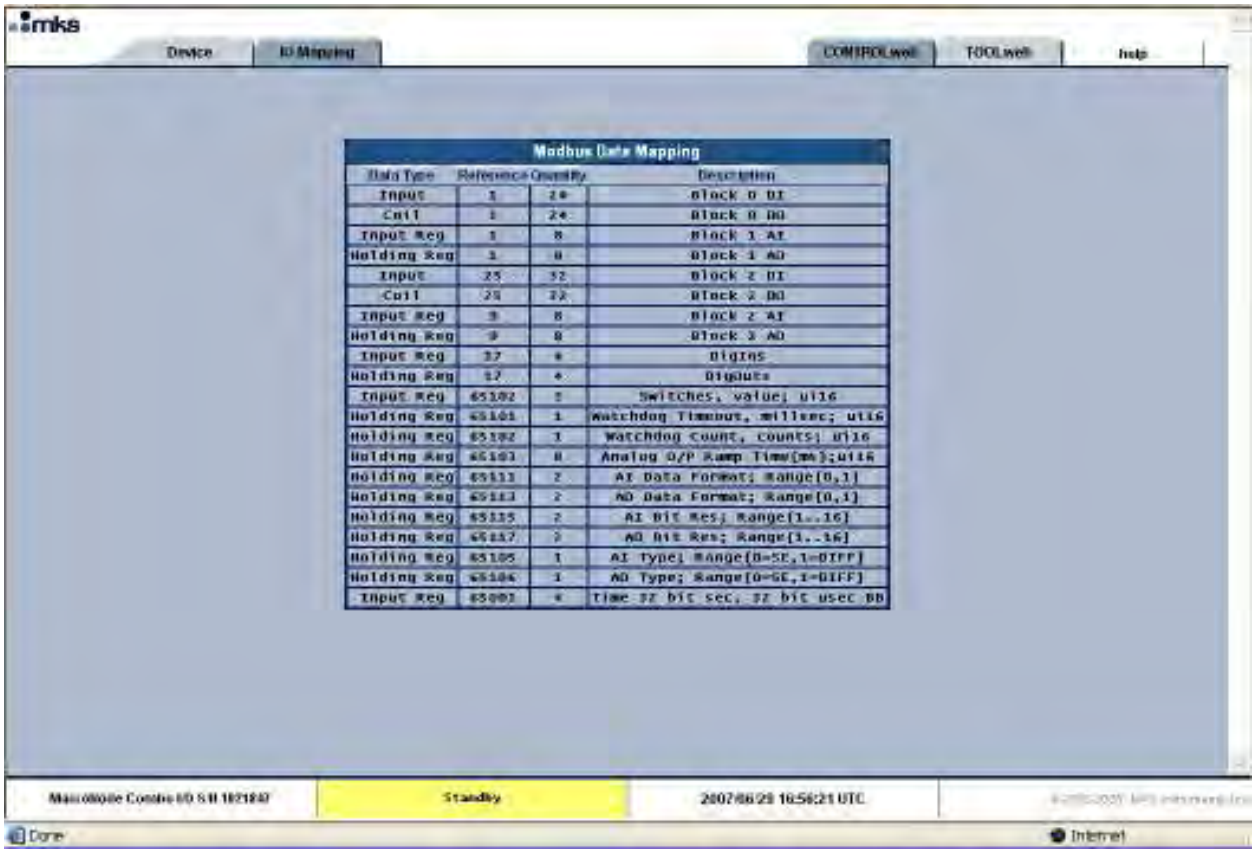

Figure 26 Modbus Data Mapping for unit with 2 expansion modules

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The MacroNode IO supports the following MODBUS Functions:

1. **ReadDiscreteInputs**. As defined in the MODBUS Application Protocol Specification, the device shall support reading one or more discrete inputs via the ReadDiscreteInputs function.
2. **ReadCoils.** For the purposes of this device, a coil shall be synonymous with a Discrete Output. As defined in the MODBUS Application Protocol Specification, the device shall support reading one or more coils (discrete outputs) via the ReadCoils function.
3. **WriteSingleCoil.**
4. **WriteMultipleCoils.**
5. **ReadHoldingRegisters**. As defined in the MODBUS Application Protocol Specification, the device shall support reading one or more registers via the ReadHoldingRegisters function.
6. **WriteSingleRegister**. Is defined to access the HoldingRegisters.

When accessing an IO point, the following method is used.

DI address = Reference of DI Number – 1

For example for DI number = 4 with a reference of 4, the DI address would be 3.

Map this data in your Modbus/TCP scanner.

Note For more details on Modbus, see http://www.modbus.org.

WATCHDOG TIMER

The Modbus/TCP Interface includes a watchdog timer to monitor and react in the event that communications are not maintained between the client and the server within a programmable amount of time. If communications exceed the timeout value (programmed into the Watchdog Timeout Value Holding Register) a timeout will occur and the Watchdog Timeout Counter register will increment 1 count for every timeout event that occurs. In the event that a timeout occurs the Status LED will alternate between red-amber and green. Once a timeout occurs all outputs are disabled.

The Watchdog Timeout value can be set from 100ms to 65535ms and can be disabled by writing a value of 0 to the register. The Watchdog Timeout Counter increments on each timeout event and is cleared by writing any value to the register.

Note To ensure that the Watchdog Counter register is cleared the register should be written to during initialization.

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3.3 I/O Mapping-Ethernet IP

The Ethernet/IP I/O details can be viewed through the web browser interface by clicking on the ***I/O Mapping Tab*** from the main page. The figure below is one example of what will appear on the screen. The mapping will change depending on which I/O expansion modules are installed.

This page provides information for Instances 100 – 103. The table is broken down by byte number as well as by the bits within said bytes. The byte total is displayed at the bottom of the table. To change the instance, use the ***Assembly Instance*** drop down menu at the top of the screen. Instances 100 and 101 do not include the virtual I/O where as instances 102 and 103 do.

Note

The I/O is arranged in blocks, which represent expansion modules. The last block is always a virtual I/O block which can be used in conjunction with the cLogic feature. Please contact MKS for the cLogic API document for more information on implementing the virtual I/O.

Figure 27 Ethernet IP I/O Mapping

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Below is an example of one way the expansion slots can be populated and the following sections explains the resulting input and output bytes for this configuration. Note this is only one example of how the expansion slots can be populated. The byte order conforms to the following rules:

- Digital control bytes for each slot always come before the analog control bytes.
- Analog falls on even byte boundaries, a null byte is used for stuffing.
- Analog is always low byte first then high byte.
- Virtual I/O is after physical I/O

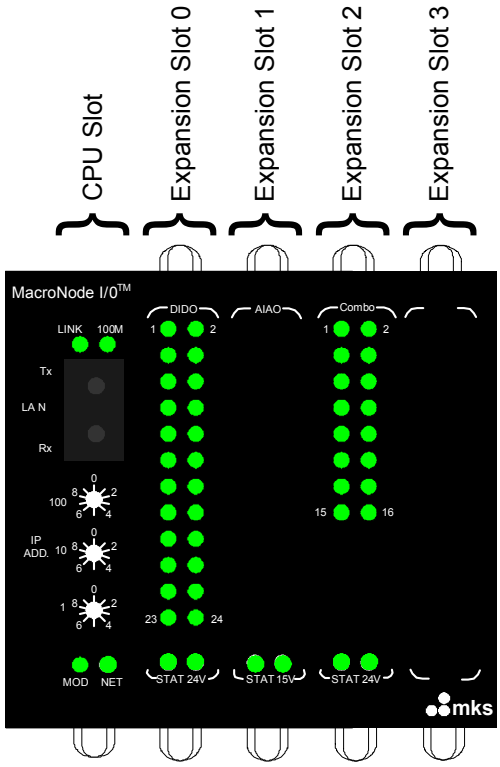

Figure 28 MacroNode with Digital, Analog, and Combo Expansion cards

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3.3.1 Assembly Instance 100

Below is an example of Instance 100, which describes the information provided by the unit (input values). This example demonstrates the fact that digital bytes always appear before analog bytes. Also notice that byte number five is a stuff byte that forces the least significant analog bytes to fall on an even byte boundary. The last line displays the total number of bytes this unit produces.

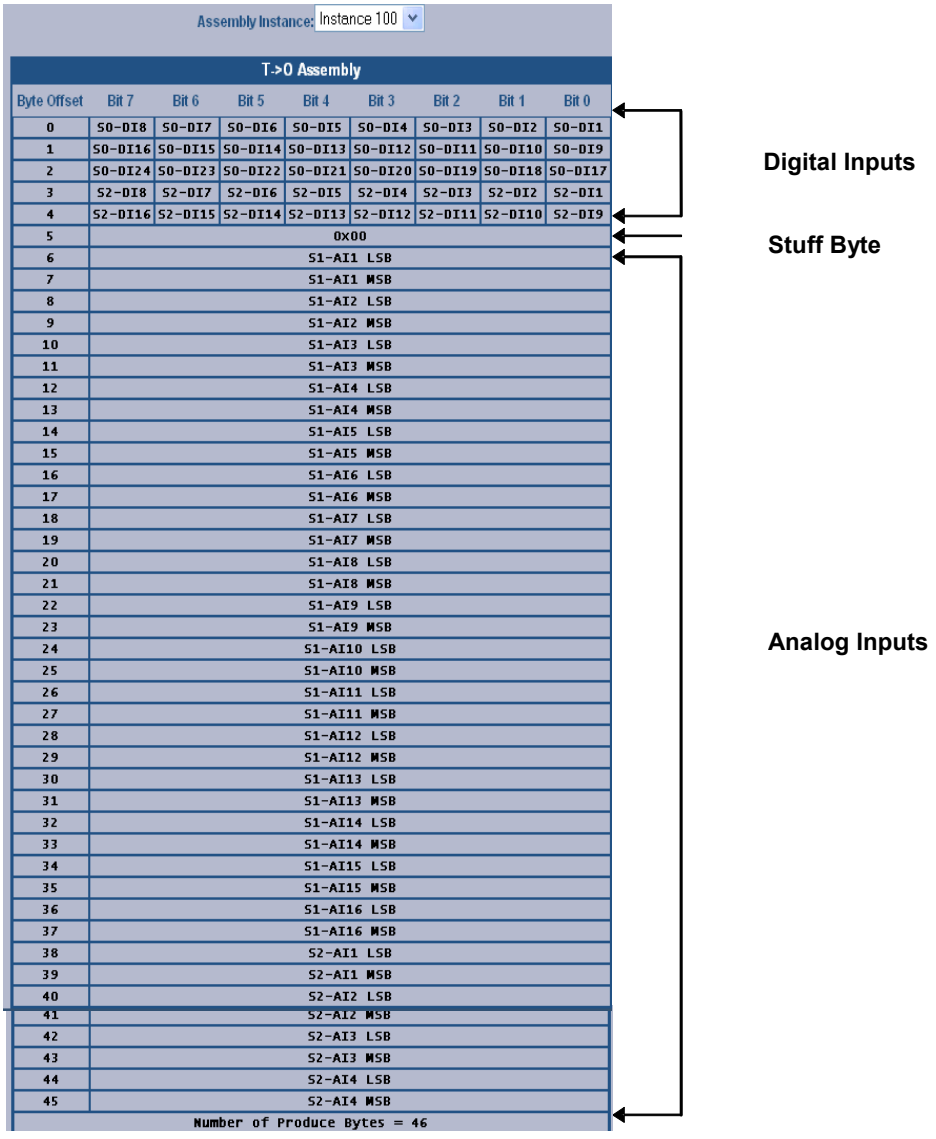

Figure 29 Instance 100-Input Mapping

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3.3.2 Assembly Instance 101

Below is an example of Instance 101, which describes the information, provided to the unit (Outputs). This example demonstrates the fact that digital bytes always appear before analog bytes. Also notice that byte number five is a stuff byte that forces the least significant analog bytes to fall on an even byte boundary. The last line displays the total number of bytes this unit consumes.

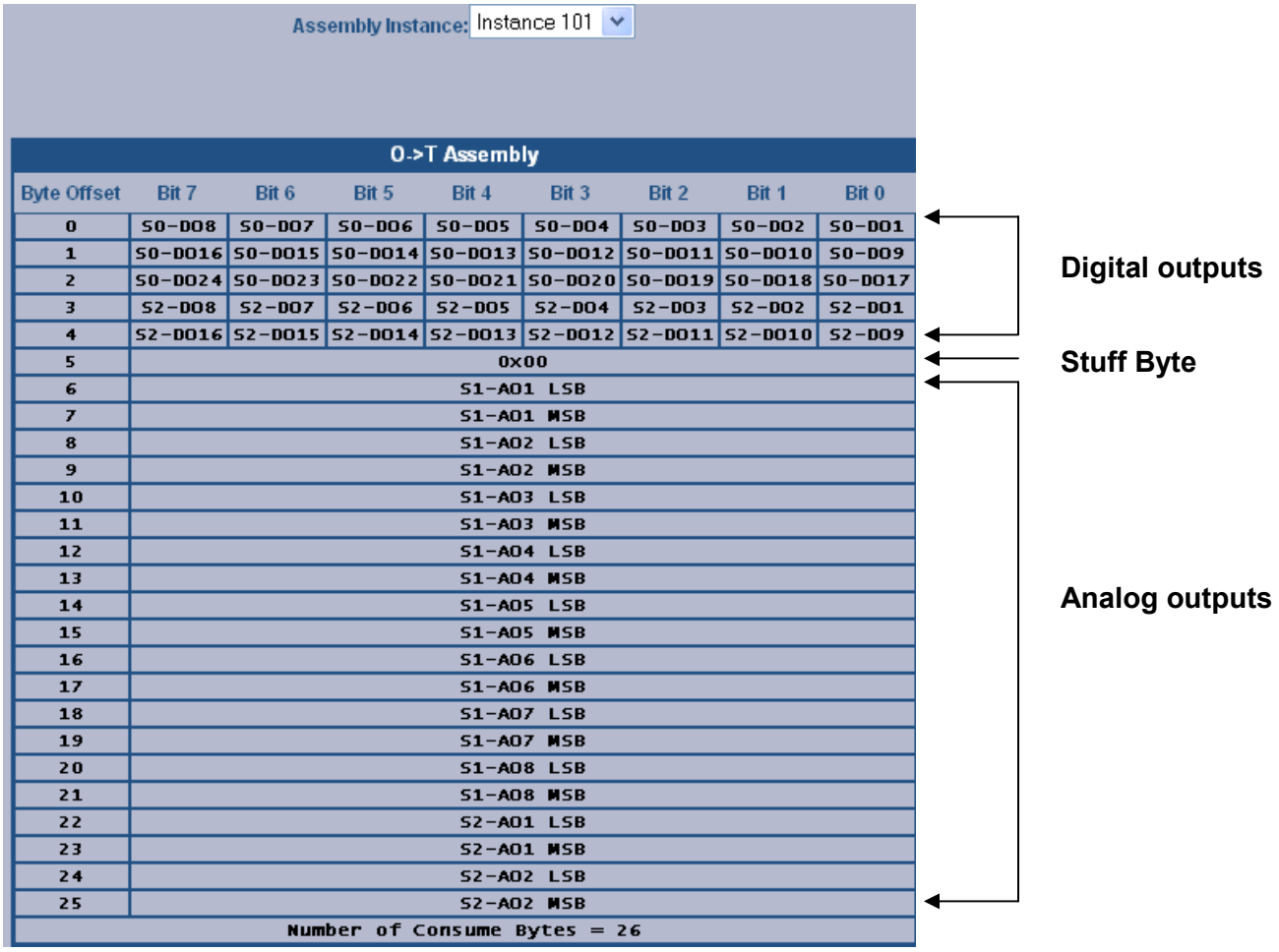

Figure 30 Instance 101-Output Mapping

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3.3.3 Assembly Instance 102

Below is an example of Instance 102, which describes the information provided by the unit (input values) plus the virtual inputs. This example demonstrates the fact that digital bytes always appear before analog bytes and physical I/O appears before virtual I/O. Also notice that byte number nine is a stuff byte that forces the least significant analog bytes to fall on an even byte boundary. The last line displays the total number of bytes this unit produces including the virtual inputs.

Assembly Instance: Instance 102

T->O Assembly

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	S0-DI8	S0-DI7	S0-DI6	S0-DI5	S0-DI4	S0-DI3	S0-DI2	S0-DI1
1	S0-DI16	S0-DI15	S0-DI14	S0-DI13	S0-DI12	S0-DI11	S0-DI10	S0-DI9
2	S0-DI24	S0-DI23	S0-DI22	S0-DI21	S0-DI20	S0-DI19	S0-DI18	S0-DI17
3	S2-DI8	S2-DI7	S2-DI6	S2-DI5	S2-DI4	S2-DI3	S2-DI2	S2-DI1
4	S2-DI16	S2-DI15	S2-DI14	S2-DI13	S2-DI12	S2-DI11	S2-DI10	S2-DI9
5	VDI8	VDI7	VDI6	VDI5	VDI4	VDI3	VDI2	VDI1
6	VDI16	VDI15	VDI14	VDI13	VDI12	VDI11	VDI10	VDI9
7	VDI24	VDI23	VDI22	VDI21	VDI20	VDI19	VDI18	VDI17
8	VDI32	VDI31	VDI30	VDI29	VDI28	VDI27	VDI26	VDI25
9	0x00							
10	S1-AI1 LSB							
11	S1-AI1 MSB							
12	S1-AI2 LSB							
13	S1-AI2 MSB							
14	S1-AI3 LSB							
15	S1-AI3 MSB							
16	S1-AI4 LSB							
17	S1-AI4 MSB							
18	S1-AI5 LSB							
19	S1-AI5 MSB							
20	S1-AI6 LSB							
21	S1-AI6 MSB							
22	S1-AI7 LSB							
23	S1-AI7 MSB							
24	S1-AI8 LSB							
25	S1-AI8 MSB							
26	S1-AI9 LSB							
27	S1-AI9 MSB							
28	S1-AI10 LSB							
29	S1-AI10 MSB							
30	S1-AI11 LSB							
31	S1-AI11 MSB							
32	S1-AI12 LSB							
33	S1-AI12 MSB							
34	S1-AI13 LSB							
35	S1-AI13 MSB							
36	S1-AI14 LSB							
37	S1-AI14 MSB							
38	S1-AI15 LSB							
39	S1-AI15 MSB							
40	S1-AI16 LSB							
41	S1-AI16 MSB							
42	S2-AI1 LSB							
43	S2-AI1 MSB							
44	S2-AI2 LSB							
45	S2-AI2 MSB							
46	S2-AI3 LSB							
47	S2-AI3 MSB							
48	S2-AI4 LSB							
49	S2-AI4 MSB							
50	VAI1 LSB							
51	VAI1 MSB							
52	VAI2 LSB							
53	VAI2 MSB							
54	VAI3 LSB							
55	VAI3 MSB							
56	VAI4 LSB							
57	VAI4 MSB							
58	VAI5 LSB							
59	VAI5 MSB							
60	VAI6 LSB							
61	VAI6 MSB							
62	VAI7 LSB							
63	VAI7 MSB							
64	VAI8 LSB							
65	VAI8 MSB							
Number of Produce Bytes = 66								

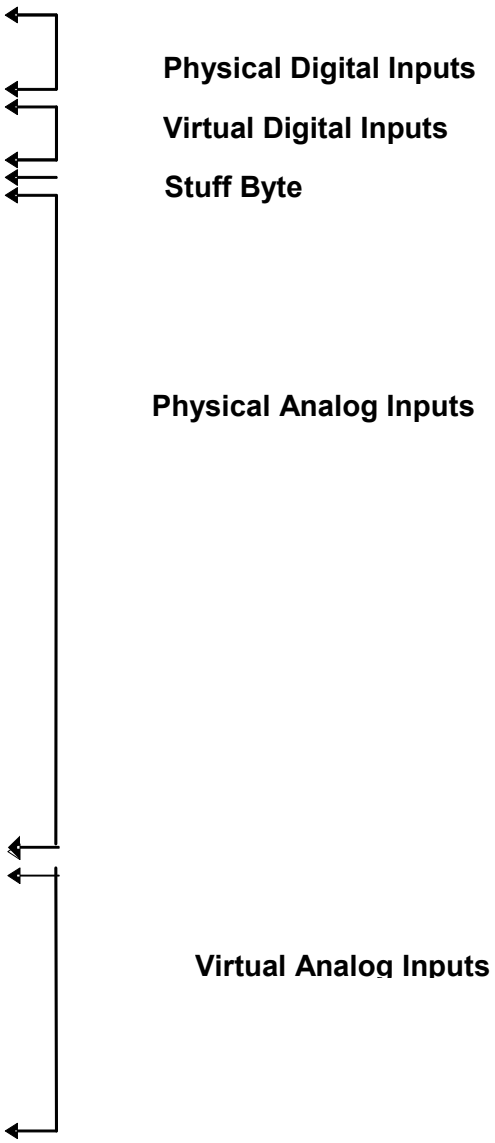

Figure 31 Instance 102-Input Mapping with Virtual I/O

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3.3.4 Assembly Instance 103

Below is an example of Instance 103, which describes the information provided to the unit (Outputs) including the virtual outputs. This example demonstrates the fact that digital bytes always appear before analog bytes and that physical I/O appears before virtual I/O. Also notice that byte number nine is a stuff byte that forces the least significant analog bytes to fall on an even byte boundary. The last line displays the total number of bytes this unit consumes including the virtual outputs.

Assembly Instance: Instance 103

O->T Assembly

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	S0-D08	S0-D07	S0-D06	S0-D05	S0-D04	S0-D03	S0-D02	S0-D01
1	S0-D016	S0-D015	S0-D014	S0-D013	S0-D012	S0-D011	S0-D010	S0-D09
2	S0-D024	S0-D023	S0-D022	S0-D021	S0-D020	S0-D019	S0-D018	S0-D017
3	S2-D08	S2-D07	S2-D06	S2-D05	S2-D04	S2-D03	S2-D02	S2-D01
4	S2-D016	S2-D015	S2-D014	S2-D013	S2-D012	S2-D011	S2-D010	S2-D09
5	VD08	VD07	VD06	VD05	VD04	VD03	VD02	VD01
6	VD016	VD015	VD014	VD013	VD012	VD011	VD010	VD09
7	VD024	VD023	VD022	VD021	VD020	VD019	VD018	VD017
8	VD032	VD031	VD030	VD029	VD028	VD027	VD026	VD025
9	0x00							
10	S1-AO1 LSB							
11	S1-AO1 MSB							
12	S1-AO2 LSB							
13	S1-AO2 MSB							
14	S1-AO3 LSB							
15	S1-AO3 MSB							
16	S1-AO4 LSB							
17	S1-AO4 MSB							
18	S1-AO5 LSB							
19	S1-AO5 MSB							
20	S1-AO6 LSB							
21	S1-AO6 MSB							
22	S1-AO7 LSB							
23	S1-AO7 MSB							
24	S1-AO8 LSB							
25	S1-AO8 MSB							
26	S2-AO1 LSB							
27	S2-AO1 MSB							
28	S2-AO2 LSB							
29	S2-AO2 MSB							
30	VAO1 LSB							
31	VAO1 MSB							
32	VAO2 LSB							
33	VAO2 MSB							
34	VAO3 LSB							
35	VAO3 MSB							
36	VAO4 LSB							
37	VAO4 MSB							
38	VAO5 LSB							
39	VAO5 MSB							
40	VAO6 LSB							
41	VAO6 MSB							
42	VAO7 LSB							
43	VAO7 MSB							
44	VAO8 LSB							
45	VAO8 MSB							
Number of Consume Bytes = 46								

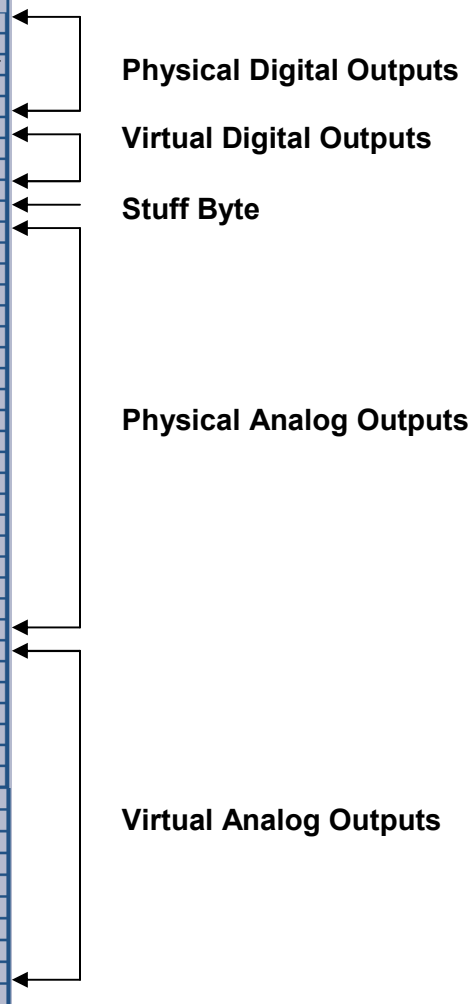

Figure 32 Instance 103- Output Mapping with Virtual I/O

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4 TOOLweb™ Interface

TOOLweb™ is a system-wide program for enabling and gathering real time data from multiple elements of a process, and providing this data to factory based modules for analysis, FDC and APC.

The Ethernet MacroNode uses TOOLweb™ functionality for the following:

- Web based tools for data analysis and debug, directly from the I/O module
- Real time data acquisition, using XML over HTTP

4.1 TOOLweb™ User Interface

TOOLweb™ functions are accessed and configured through the web browser interface. Users must determine the I/O points of interest, those usually referred to as Key Process Variables. Once these variables are named and scaled, they are available for data collection and analysis.

4.1.1 Control Access

Create the allowed permissions to process data.

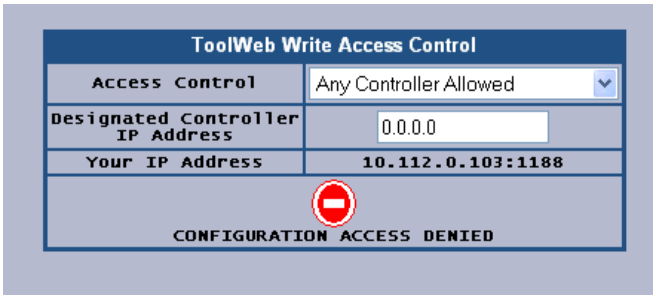

Figure 33 Access Control

4.1.2 I/O Bindings

Select the I/O points to be available for TOOLweb™ functions. Each point is selected, given a description, and scaled to meaningful process units. Up to 64 variables can be configured.

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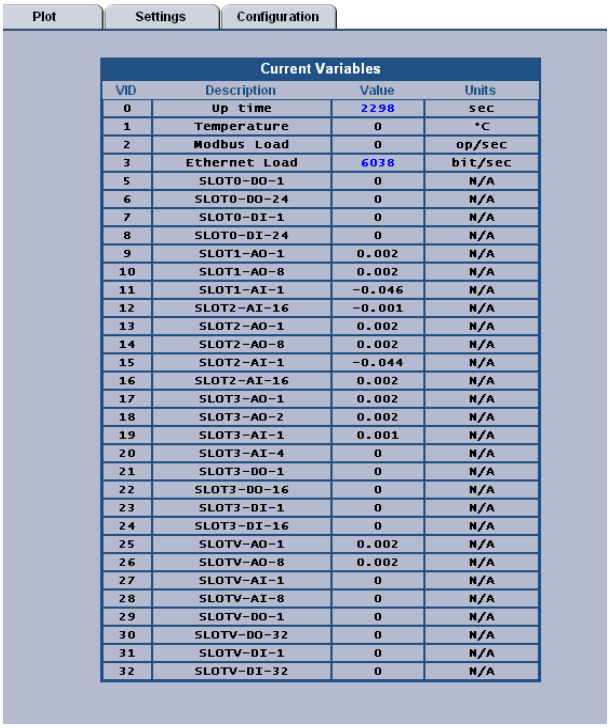

Current Variables

VID	Description	Value	Units
0	Up time	2298	sec
1	Temperature	0	°C
2	Modbus Load	0	op/sec
3	Ethernet Load	6038	bit/sec
5	SLOT0-DO-1	0	N/A
6	SLOT0-DO-24	0	N/A
7	SLOT0-DI-1	0	N/A
8	SLOT0-DI-24	0	N/A
9	SLOT1-AO-1	0.002	N/A
10	SLOT1-AO-8	0.002	N/A
11	SLOT1-AI-1	-0.046	N/A
12	SLOT2-AI-16	-0.001	N/A
13	SLOT2-AO-1	0.002	N/A
14	SLOT2-AO-8	0.002	N/A
15	SLOT2-AI-1	-0.044	N/A
16	SLOT2-AI-16	0.002	N/A
17	SLOT3-AO-1	0.002	N/A
18	SLOT3-AO-2	0.002	N/A
19	SLOT3-AI-1	0.001	N/A
20	SLOT3-AI-4	0	N/A
21	SLOT3-DO-1	0	N/A
22	SLOT3-DO-16	0	N/A
23	SLOT3-DI-1	0	N/A
24	SLOT3-DI-16	0	N/A
25	SLOTV-AO-1	0.002	N/A
26	SLOTV-AO-8	0.002	N/A
27	SLOTV-AI-1	0	N/A
28	SLOTV-AI-8	0	N/A
29	SLOTV-DO-1	0	N/A
30	SLOTV-DO-32	0	N/A
31	SLOTV-DI-1	0	N/A
32	SLOTV-DI-32	0	N/A

Figure 34 Collection Variables

4.1.3 Data Collection Plans

A data collection plan selects the process variables of interest, and the frequency of data collection. Each collection plan can then be viewed using a Charting Applet, or can be downloaded in CSV format to your local PC.

Data Collection Plans

Plan Name	Period (milliseconds)	Log Size (Retention Time)		Variables VID
Default_CP	5000	127 10.6 min	View, Download Plot, Edit	0-3
Unused_01	0	Off	Edit	-
Unused_02	0	Off	Edit	-
Unused_03	0	Off	Edit	-
Unused_04	0	Off	Edit	-
Unused_05	0	Off	Edit	-
Unused_06	0	Off	Edit	-
Unused_07	0	Off	Edit	-

Figure 35 Collection Plan

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4.1.4 Data Collection Plan Editing

Create a collection plan, and select the key process variables of interest:

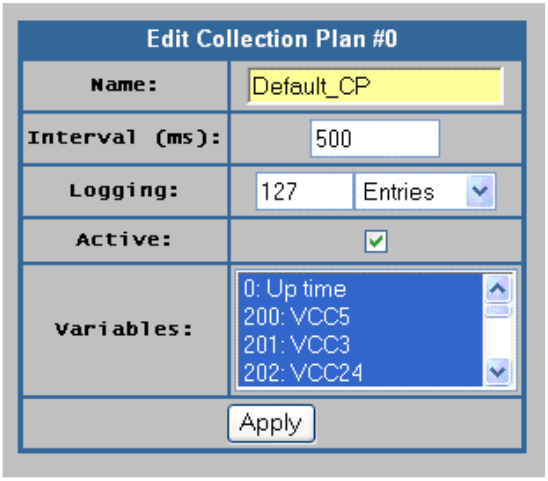

Figure 36 Edit Collection Plan

4.1.5 Charting Applet

Once a data collection plan is configured, you can view the data using a built-in charting applet.

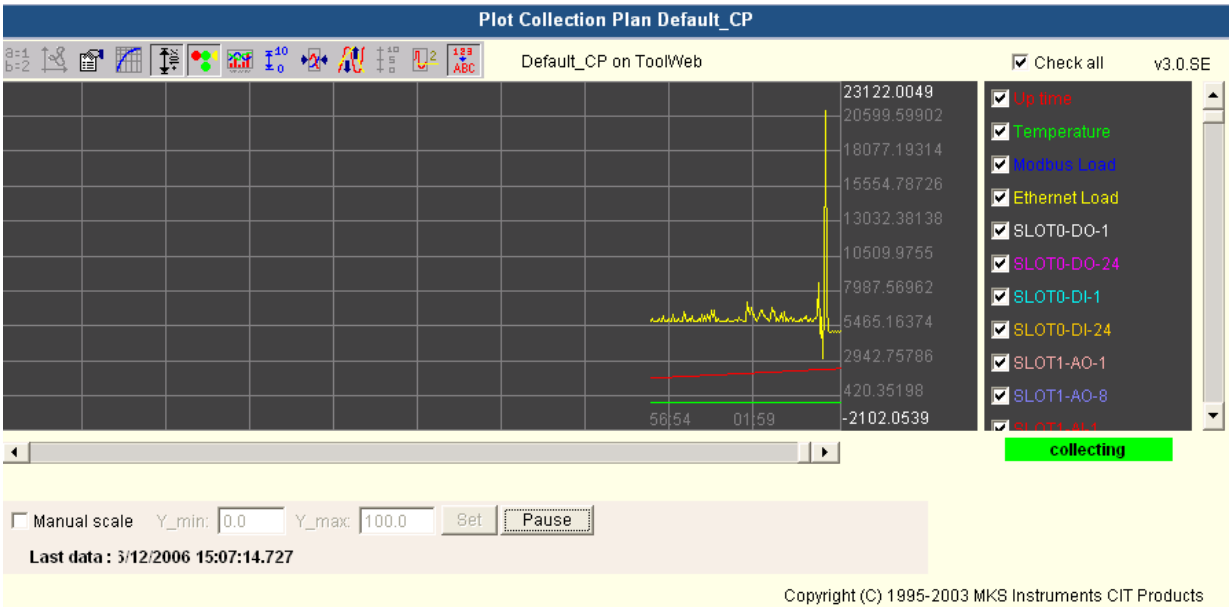

Figure 37 Charting Applet

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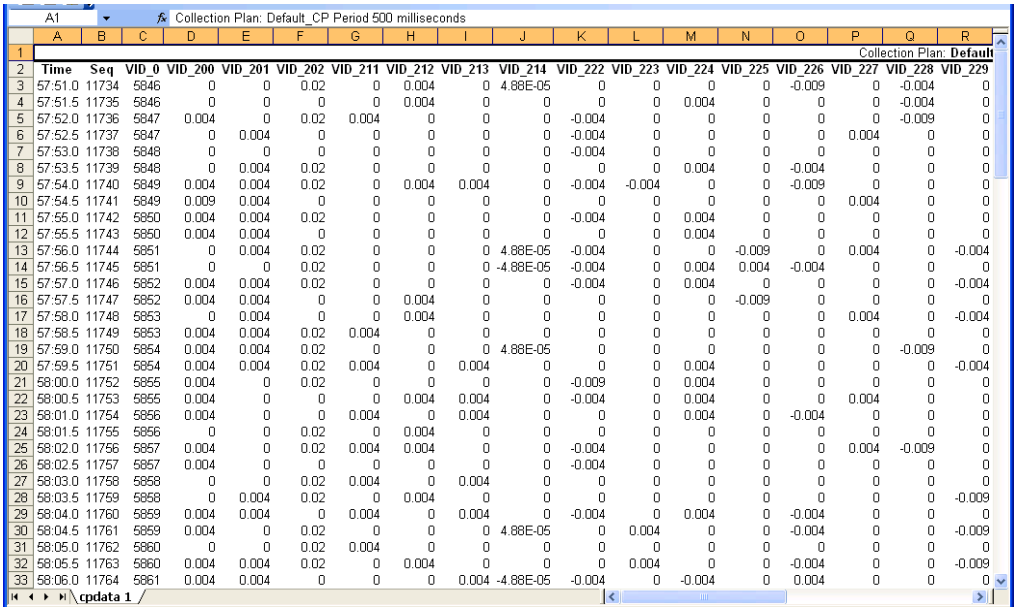
4.1.6 Download Data to Local PC

Collection plan data can also be downloaded in CSV format:



Collection Plan: Default_CP Period 500 milliseconds

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																	Collection Plan:	Default
2	Time	Seq	VID_0	VID_200	VID_201	VID_202	VID_211	VID_212	VID_213	VID_214	VID_222	VID_223	VID_224	VID_225	VID_226	VID_227	VID_228	VID_229
3	57:51.0	11734	5846	0	0	0.02	0	0.004	0	4.88E-05	0	0	0	0	-0.009	0	-0.004	0
4	57:51.5	11735	5846	0	0	0	0	0.004	0	0	0	0	0.004	0	0	0	-0.004	0
5	57:52.0	11736	5847	0.004	0	0.02	0.004	0	0	0	-0.004	0	0	0	0	0	-0.009	0
6	57:52.5	11737	5847	0	0.004	0	0	0	0	0	-0.004	0	0	0	0	0.004	0	0
7	57:53.0	11738	5848	0	0	0	0	0	0	0	-0.004	0	0	0	0	0	0	0
8	57:53.5	11739	5848	0	0.004	0.02	0	0	0	0	0	0	0.004	0	-0.004	0	0	0
9	57:54.0	11740	5849	0.004	0.004	0.02	0	0.004	0.004	0	-0.004	-0.004	0	0	-0.009	0	0	0
10	57:54.5	11741	5849	0.009	0.004	0	0	0	0	0	0	0	0	0	0	0.004	0	0
11	57:55.0	11742	5850	0.004	0.004	0.02	0	0	0	0	-0.004	0	0.004	0	0	0	0	0
12	57:55.5	11743	5850	0.004	0.004	0	0	0	0	0	0	0	0.004	0	0	0	0	0
13	57:56.0	11744	5851	0	0.004	0.02	0	0	0	4.88E-05	-0.004	0	0	-0.009	0	0.004	0	-0.004
14	57:56.5	11745	5851	0	0	0.02	0	0	0	-4.88E-05	-0.004	0	0.004	0.004	-0.004	0	0	0
15	57:57.0	11746	5852	0.004	0.004	0.02	0	0	0	0	-0.004	0	0.004	0	0	0	0	-0.004
16	57:57.5	11747	5852	0.004	0.004	0	0	0.004	0	0	0	0	0	-0.009	0	0	0	0
17	57:58.0	11748	5853	0	0.004	0	0	0.004	0	0	0	0	0	0	0	0.004	0	-0.004
18	57:58.5	11749	5853	0.004	0.004	0.02	0.004	0	0	0	0	0	0	0	0	0	0	0
19	57:59.0	11750	5854	0.004	0.004	0.02	0	0	0	4.88E-05	0	0	0	0	0	0	-0.009	0
20	57:59.5	11751	5854	0.004	0.004	0.02	0.004	0	0.004	0	0	0	0.004	0	0	0	0	-0.004
21	58:00.0	11752	5855	0.004	0	0.02	0	0	0	0	-0.009	0	0.004	0	0	0	0	0
22	58:00.5	11753	5855	0.004	0	0	0	0.004	0.004	0	-0.004	0	0.004	0	0	0.004	0	0
23	58:01.0	11754	5856	0.004	0	0	0.004	0	0.004	0	0	0	0.004	0	-0.004	0	0	0
24	58:01.5	11755	5856	0	0	0.02	0	0.004	0	0	0	0	0	0	0	0	0	0
25	58:02.0	11756	5857	0.004	0	0.02	0.004	0.004	0	0	-0.004	0	0	0	0	0.004	-0.009	0
26	58:02.5	11757	5857	0.004	0	0	0	0	0	0	-0.004	0	0	0	0	0	0	0
27	58:03.0	11758	5858	0	0	0.02	0.004	0	0.004	0	0	0	0	0	0	0	0	0
28	58:03.5	11759	5858	0	0.004	0.02	0	0.004	0	0	0	0	0	0	0	0	0	-0.009
29	58:04.0	11760	5859	0.004	0.004	0	0.004	0	0.004	0	-0.004	0	0.004	0	-0.004	0	0	0
30	58:04.5	11761	5859	0.004	0	0.02	0	0	0	4.88E-05	0	0.004	0	0	-0.004	0	0	-0.009
31	58:05.0	11762	5860	0	0	0.02	0.004	0	0	0	0	0	0	0	0	0	0	0
32	58:05.5	11763	5860	0.004	0.004	0.02	0	0.004	0	0	0	0.004	0	0	-0.004	0	0	-0.009
33	58:06.0	11764	5861	0.004	0.004	0	0	0	0.004	-4.88E-05	-0.004	0	-0.004	0	0.004	0	0	0

cpdata 1

Figure 38 Collection Plan Data

4.2 TOOLweb™ Tool Side Interface

The tool side interface is relevant when a MacroNode is connected to a BlueBox™ in a semiconductor process tool APC, and e-diagnostic system.

The following messages are supported via the TOOLweb™ tool side Interface:

Message	Supported
CapabilitiesRequest/Response	Yes
Polling	Yes
Tracing	Yes
Bulktrace	No
Events	No
ControlParameter	Yes
SetRequest/Response	No

The names and units as exposed in the CapabilitesResponse are the same as defined in the channel configuration. Reference the BlueBox™ Manual for additional details on interfacing with BlueBox™.

Note Microsoft Internet Explorer 5.0.1 or higher is required. Microsoft Internet Explorer versions less than 5.5 may not function as expected due to limitations of the browser.

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5 Specifications

Physical Specifications

Criteria	Specifications
Dimensions	4” H x 4” W x 1.5”D plus 0.7” per I/O slot
I/O Connector	37-pin male D-sub
Ethernet Connector	10/100 BaseT auto-switched, RJ45 with EMI filter, LED indicators OR Fiber optic connector
RS-232 Connector	TXD, RXD; DB9 connector
Weight	600g (1.32 lb)

Environmental Specifications

Criteria	Specifications
Operating Temperature	0 to +55°C
Storage	-40 to +85 °C
Humidity	5 to 95% non-condensing

Functional Specifications

Criteria	Specifications
BUS Interface	Ethernet – Modbus/TCP or Ethernet/IP
Front Panel Indicators	Network Status, Module Status, LINK, 100MB
Rotary Switches	IP address, operating mode

Power Specifications

Criteria	Specifications
Input	Powered from I/O connector +24VDC@120 mA min
Isolation	DC/DC Isolation

Power Specifications

Criteria	Specifications
Input	Powered from I/O connector +24VDC@120 mA min
Isolation	DC/DC Isolation, 2.5KVrms
Over Current Protection Each Channel Total	 1.5A 3.0A

Input/Output Specifications per Card

Criteria	Specifications
DIDO Card	
Number of Digital I/O	24 points (input or output)
Response Time	50µsec
Digital Input Sink Current sinking Logic Low Voltage Logic High Voltage Source Current sourcing Input Low Voltage	 Max -2.18 mA at Vin=0V Min 4.1V to Max 30V Min 0V to Max 3.6V Max 2.33 mA at Vin=24V Min 0V to Max 6V

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Input High Voltage	Min 6.5V to Max 30V
Digital Output	
Sink	
Current sinking	200 mA max / channel
Output OFF Voltage	Min 23.8V @ 580uA @ R_L=240Ω Min 23.8V @ 1mA @ R_L=120Ω
Output ON Voltage	Max 240mV @ 200mA @ R_L=120Ω Max 133mV @ 100mA @ R_L=240Ω
Source	
Current sourcing	200 mA max / channel
Current max	750 mA per 6 DO
Output ON Voltage	Min 23.3V @ 100mA @ R_L=240Ω Min 23.1V @ 200mA @ R_L=120Ω
Output OFF Voltage	Max 0V @ 0uA @ R_L=120Ω Max 0V @ 0mA @ RL=240Ω

AIAO Card	
Analog Accuracy	0.1% Full scale (-10V to 10V)
Analog Response Time	200 µsec
Analog Input	16 single-ended points or 8 differential points (s/w selectable) 14 bit 1Khz RC filter
Analog Output	8 single-ended points 12 bit Range (–10 to +10V) 5mA / channel into a 2 KΩ load

COMBO Card	
Number of Digital I/O	16 points (input or output)
Response Time	50 µsec
Digital Input	
Current sinking	1.5 mA min,
Current sourcing	1.5 mA min,
Digital Output	
Current sinking	200 mA max / channel
Current sourcing	200 mA max / channel
Current max	750 mA per 6 DO
Analog Accuracy	0.1% Full scale (-10V to 10V)
Analog Response Time	200 µsec
Analog Input	4 differential points (s/w selectable) 14 bit 1khz RC filter
Analog Output	2 differential points 12 bit Range (–10 to +10V) 5mA / channel into a 2 KΩ load

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6 Model Code Description

The Model code of MacroNode defines the features of the Unit for Hardware, software and other options:

	BASE		OPTIONS		SLOT 1		SLOT 2		SLOT 3		SLOT 4
Format:	MNOD	-	E	-	DIDO	-	DIDO	-	DIDO	-	DIDO
			FE		AIAO		AIAO		AIAO		AIAO
					AI		AI		AI		AI
					AIC		AIC		AIC		AIC
					COMB		COMB		COMB		COMB

Options

-E	Ethernet, RJ45
-FE	Ethernet, Fiberoptic

Slot Designations

-DIDO	24 Channel Digital I/O Card
-AIAO	16 Channel Analog In, 8 Channel Analog Out
-AI	16 Analog Inputs (Voltage Type Inputs)
-AIC	8 Analog Inputs (Current Type Inputs)
-COMB	Combination: 16DIDO, 4AI-DIF, 2AO-DIF

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For the period commencing with the date of shipment of this equipment and ending one year later, **MKS** will, at its option, either repair or replace any part which is defective in materials or workmanship or with respect to the date-related operations warranty without charge to the purchaser. The foregoing shall constitute the exclusive and sole remedy of the purchaser for any breach by **MKS** of this warranty.

The purchaser, before returning any equipment covered by this warranty, which is asserted to be defective by the purchaser, shall make specific written arrangements with respect to the responsibility for shipping the equipment and handling any other incidental charges with the **MKS** sales representative or distributor from which the equipment was purchased or, in the case of a direct purchase from **MKS**, with the **MKS-CIT** home office in San Jose, CA

This warranty does not apply to any equipment, which has not been installed and used in accordance with the specifications recommended by **MKS** for the proper and normal use of the equipment. **MKS** shall not be liable under any circumstances for indirect, special, consequential, or incidental damages in connection with, or arising out of, the sale, performance, or use of the equipment covered by this warranty.

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